JACIE

Joint Agency Commercial Imagery Evaluation

Civil Commercial Imagery Evaluation Workshop

Boulder Marriott Hotel, Boulder, Colorado

March 29-31, 2011

Flat Irons in Spring

USGS science for a changing world

USDA

Joint Agency Commercial Imagery Evaluation

JACIE

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Civil Commercial Imagery Evaluation Workshop

Hosted by

NASA, NGA, USDA, USGS

March 29-31, 2011

Contents

KEYNOTE SPEAKERS
Biographies

Anne Hale Miglarese

Ms. Miglarese is a Principal with Booz Allen Hamilton, a technology and consulting firm in Mclean Virginia. Anne is focused on growing Booz Allen's geospatial solutions and services business in the Federal civilian market. Prior to joining Booz Allen Anne was president and CEO of EarthData International (now known as Fugro EarthData) an airborne mapping, remote sensing, and geographic information system (GIS) services Company that operates throughout the United States as well as internationally.
Prior to joining EarthData, Ms. Miglarese worked for the National Oceanic and Atmospheric Administration's Coastal Services Center, where she directed the remote sensing and GIS programs of the organization for 10 years.. Throughout her career, Ms. Miglarese has worked for numerous state agencies including the South Carolina Department of Health and Environmental Control, the Water Resources Commission, and the Department of Natural Resources. She began her career in the private sector as an environmental consultant specializing in regulatory compliance for the Clean Water Act and National Environmental Policy Acts

Active in national policy governing spatial data, Ms. Miglarese is chairman of the National Geospatial Advisory Committee and is presently on the Board of TerraGo Technologies. Anne previously served on the Editorial Advisory Board of *Imaging Notes, GeoSpatial Solutions and GIS World*. Anne is a past Chairwoman of the Federal Geographic Data Committee's Marine and Coastal Spatial Data Subcommittee. She was a founding member of the National States Geographic Information Council, past chairwoman of the South Carolina State Mapping Advisory Committee, and a previous board member of the Urban and Regional Information Systems Association and on the Board of Directors of the Management Association of Private Photogrammetrist and Surveyors (MAPPS).

Ms. Miglarese has a B.S. and M.S. in geography from the University of South Carolina.

William Gail

William B. Gail is a Director in the Startup Business Group at Microsoft with responsibility for enabling breakthroughs in consumer software, having held similar positions within the Public Sector and Virtual Earth organizations. He is also co-founder and Chief Technology Officer of Global Weather Corporation, a private-label provider of precision weather forecast information. He was previously Vice President of the mapping products division at Vexcel Corporation (where he initiated Vexcel's 2006 acquisition by Microsoft) and Director of Earth science programs at Ball Aerospace (responsible for developing spaceborne instruments/missions for Earth science and meteorology). Dr. Gail received his undergraduate degree in Physics and his PhD in Electrical Engineering from Stanford University, where his research focused on plasma physics in the Earth's magnetosphere. During this period, he spent a year as cosmic ray field scientist at South Pole Station.

Dr. Gail is a lifetime Associate of the US National Academy of Science's research council, having participated on a number of council committees including the current review of the National Weather Service modernization as well as the "Decadal Survey" chartered with recommending a 10-year mission plan for NASA and NOAA. He serves on a variety of corporate and organizational boards including Peak Weather Resources Inc., Women in Aerospace, Imaging Notes magazine, the NOAA Advisory Committee on Commercial Remote Sensing (acting), the NASA Applied Sciences Program Advisory Group, and the IEEE Geoscience and Remote Sensing Society. He has published extensively on both technical and policy issues and received recent awards from GITA for best conference speaker and AGU for excellence in scientific journal review.

Charles Mondello

As a Senior VP and Deputy CTO Mr. Mondello provides corporate development and guidance at Pictometry International. As such, Mr. Mondello is involved in engineering, production, marketing and sales. His aerial experience comes from his technical development and marketing work for Earth Data Technologies, Litton's former Emerge, Eastman Kodak and IBM, where he led both imaging and remote sensing programs. Mr. Mondello served as a federal employee where he managed data collection, processing, and production technologies.

Mr. Mondello's accomplishments have been recognized by his peers in his selection as a past Director of the ASPRS Primary Data Acquisition Division, and by his election as the Chair of the ASPRS 10-Year Remote Sensing Industry Forecast spanning the last decade. Mr. Mondello has developed the Digital Aerial Guideline for ASPRS. He has been elected (2009) as the Chair of the industry guideline for Commercial Geospatial Mapping Products. He holds four ASPRS Presidential Citations. He has been twice nominated to run for ASPRS President. He is the author of multiple papers in trade journals and is a supporting author in Manual of Photogrammetry 5th Edition. He is a holder of multiple patents in Remote Sensing. Mr. Mondello served on the inaugural Secretary of the Interior's National Geospatial Advisory Committee.

Mr. Mondello holds both Bachelor and Master of Science in Imaging Science from the RIT. Mr. Mondello is also a certified Geographic Information Systems Professional.

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AGENDA

Tuesday, March 29, 2011

8:00 a.m.	Registration		
9:00 a.m.	Welcome:	Greg Stensaas	Remote Sensing Technologies Project Manager, USGS EROS
9:10 a.m.	Keynote:	Anne Miglarese	Principal, Booz Allen Hamilton
9:40 a.m.	Keynote:	Bill Gail	Director in the Startup Business Group at Microsoft
10:10 a.m.	Keynote:	Charlie Mondello	Executive Vice President of Corporate Development at Pictometry
10:40 a.m.	**Break**		

GOVERNMENT OVERVIEW SESSION

10:55 a.m.	USGS	James Verdin	Deputy Director, National Integrated Drought Information System
11:15 a.m.	NGA	Dan Schuresko	NGA CIDAP Technical Executive
11:35 a.m.	USDA	Curt Reynolds	Deputy Director for the International Production Assessment Division (IPAD) of USDA

12:00 p.m. **Lunch** (provided with registration) Set up posters

Tuesday, March 29, 2011, continued

GOVERNMENT OVERVIEW SESSION (cont.)

1:15 p.m.	NASA	TBD	TBD	
1:35 p.m.	NOAA	Cao, ChangYong	Satellite Meteorology and Climatology Division	
1:55 p.m.	**Panel Discussion: REMOTE SENSING HOT TOPICS with Keynote Speakers and Government Agency Representatives - Co-Moderators: Greg Stensaas and Kurt Thome**			
2:55 p.m.	**Break**			

Session 1: **LDCM - Chair: Mike Benson**

3:10 p.m.	11.080 (abstract #)	Markham, Brian	NASA/GSFC	The Landsat Data Continuity Mission: Status and Plans
3:25 p.m.	11.070	Knight, Edward	Ball Aerospace and Technologies Corp.	The Operational Land Imager: Overview and Requirements
3:40 p.m.	11.145	Thome, Kurt	NASA/GSFC	Calibration overview for the Thermal Infrared Sensor (TIRS) on the Landsat Data Continuity Mission
3:55 p.m.	11.017	Chander, Goward, and Pagnutti	EROS, University of Maryland, I2R Corp,	Complementarity of IRS-P6 AWiFS and Landsat TM/ETM+ sensors for Land Cover Change Analysis
4:10 p.m.	4:15 PM	Wrap Up	Mike Benson	
4:20 p.m.	Poster Session / Reception			
6:00 p.m.	Load Bus for Microsoft Tour (Agenda and sign up at registration table…limited to first 50)			
6:15 p.m.	Microsoft Tour: Jerry Skaw and Colleagues			

Wednesday, March 30, 2011

8:00 a.m. Registration

Session 2: **MEDIUM RESOLUTION - Chair: Kurt Thome**

8:30 a.m.	11.075	Mackin, Stephen and Chander, Gyanesh	DMCii and USGS/EROS	Cross-Calibration trending of the 2nd Generation DMC SLIM-6-22 and Landsat 7 ETM+ sensors over the Libya 4 CEOS reference pseudo-invariant test site
8:55 a.m.	11.030	Déliot, Mr. Philippe	ONERA	On-orbit defocus assessment of satellite cameras using neural network
9:20 a.m.	11.025 and 11.038	Liporace, Dr. Frederico and Fonseca, Dr. Leila M.G.	INPE (Brasil)	CBERS Program Update and Enhancement of HRC, and CCD images of the CBERS-2B Satellite
9:50 a.m.	11.010	Brunn, Dr. Andreas	RapidEye AG	Spatial Resolution Assessment of RapidEye Image Products
10:05 a.m.	11.100	Naughton, Denis	RapidEye AG, Germany	Radiometric Performance Assessment of the RapidEye Constellation
10:20 a.m.	11.160	Weichelt, Horst	RapidEye AG, Germany	New RapidEye Image Products
10:35 a.m.	**Break**			
10:50 a.m.	11.050	Helder, Dennis	SDSU	Absolute Calibration of Landsat 1 through Landsat 5 MSS Sensors: Extending the Data Record Back Through Time.

Wednesday, March 30, 2011, continued

11:15 a.m.	11.107	Pirondini, Fabrizio	DEIMOS Imaging S.L.	The Deimos-1 Mission: Absolute Calibration and Data Validation
11:40 a.m.	11.110	Reulke, Dr. Ralf	DLR, Germany	Spatial Resolution Assessment of Real Image Data

12:05 p.m. **Lunch** (provided with registration) Posters available for viewing

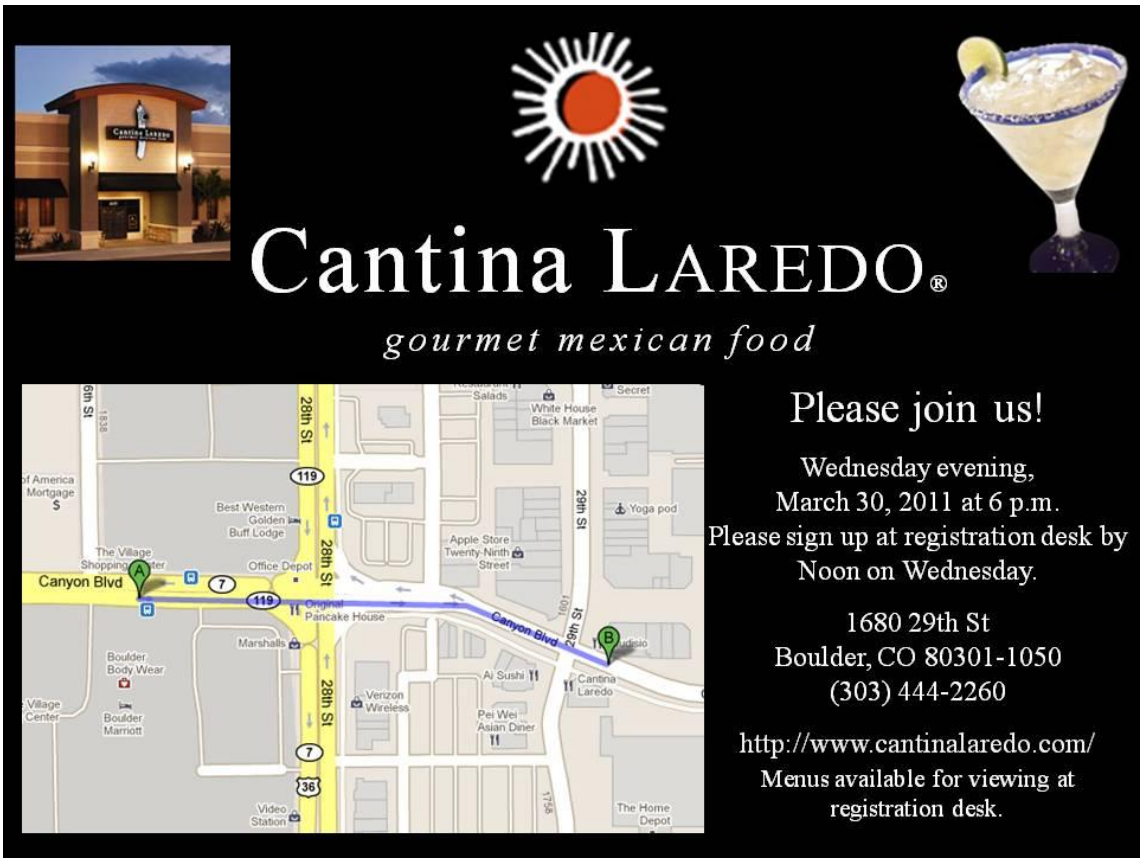
Session 3: **HIGH RESOLUTION - Chair: Dave Sedlak**

1:15 p.m.	11.005 and 11.008	Bresnahan, Paul	NGA	Geolocation Accuracy Evaluations of WorldView-1 and WorldView-2, and Geolocation Accuracy Monitoring of High Resolution Commercial Imagery
1:45 p.m.	11.035	Mattox, Preston	GeoEye, Inc	Introducing the GeoEye Sensor Performance Lab
2:10 p.m.	11.095	Mulawa, Dr. David	GeoEye	GeoEye-1 Geolocation Assessment and Reporting Update
2:35 p.m.	11.135	Stussi, Nicolas	Astrium GEO-Information Services	Pleiades Program – Capabilities and Access
3:00 p.m.	**Break**			
3:15 p.m.	11.137	Tao, Dr. Jianwei (unable to attend)	Shanghai Jiao Tong University	A Preliminary study on imaging time difference among bands of Worldview-2 and its potential applications

Wednesday, March 30, 2011, continued

3:40 p.m.	11.165	Zamudio, Joe	ITT VIS (Boulder)	Spatial and spectral processing of ASTER and WorldView-2 data
4:05 p.m.	11.143	Thomassie, Brett	DigitalGlobe	DigitalGlobe Incorporated Satellite and Aerial Program Update
4:30 p.m.	11.125 and 11.126	Smiley, Dr. Byron	DigitalGlobe	Geolocation Accuracy Topics Relevant to DigitalGlobe's Satellite Constellation
4:55 p.m.	**Wrap up**	Closing Remarks	Dave Sedlak	

6:00 p.m. No Host Dinner (on your own) at Cantina Laredo. Please join us.



Thursday, March 31, 2011

8:00 a.m. Registration

Session 4: AERIAL - Chair: Jon Christopherson

8:30 a.m.	11.040	Gruber, Dr. Michael	Microsoft (Graz, Austria)	The Evolution of Vexcel's Camera Calibration and Image Processing Technology
8:55 a.m.	11.045	Heinrichs, Tom	Geographic Information Network of Alaska	Historic and Current Status of Alaska Orthoimagery and Elevation Mapping and Alaska Statewide Mapping Program Overview
9:20 a.m.	11.065	Kinn, Gerald J.	ESRI	ArcGIS Geometric Accuracy Evaluation
9:45 a.m.	11.085	McCorkel, Joel	National Ecological Observatory Network (NEON), Inc. (Boulder, CO)	Airborne remote sensing instrumentation for the National Ecological Observatory Network
10:10 a.m.	11.105	Neuman, Klaus	Z/I Imaging, Germany	The new DMC II high resolution aerial sensor family

10:35 a.m. **Break**

Session 5: OTHER IMAGING SENSORS - Chair: John Findley

10:50 a.m.	11.161	Wagner, Rueidi	Leica	New Technology/RCD30

Thursday, March 31st, continued

11:15 a.m.	11.060	Kim, Taejung	Inha University (Korea), Dept. of Geoinformatics Engineering	Automated assessment of NIIRS and GRD of high resolution satellite images through edge profile analysis of natural targets
11:40 a.m.	11.106	Pagnutti, Mary	Innovative Imaging and Research Corp	An Automated Method to Estimate In-flight Image Quality Parameters from High Spatial Resolution Imagery
12:05 p.m.	11.115	Schiller, Stephen	Raytheon Space and Airborne Systems	Measuring Atmospheric Optical Depth Directly from Satellite Imagery

12:30 p.m. **Lunch** (provided with registration) Take posters down

Session 5: **OTHER IMAGING SENSORS, Continued - Chair: Jeff Clauson**

1:30 p.m.	11.120	Serbin, Guy	ASRC Research and Technology Solutions	Advanced Multispectral Sensor Requirements for Remote Sensing of Agriculture and Land Cover
1:55 p.m.	11.130	Stanzel, Steve	Microsoft, Boulder, CO	Microsoft Bing Maps Imagery Technologies: Commercial Imagery & Technologies
2:20 p.m.	11.146	Thome, Kurt	NASA/GSFC	Methods for radiometric cross-calibration of imaging sensors with and without overlapping collections

2:45 p.m. **Break**

Thursday, March 31, 2011, continued

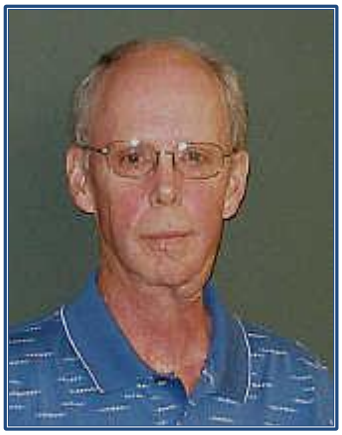
Session 6: **LiDAR, RADAR, - Chair: Greg Stensaas**

3:00 PM	11.009 and 11.006	Bresnahan, Paul	NGA	Geolocation Accuracy Evaluation of Radarsat-2 Spotlight and UltraFine Imaging Mode Products, and Geolocation Accuracy Re-Evaluation of Cosmo-Skymed Spotlight and Stripmap Imaging Mode Products
3:25 PM	11.096	Munjy, Riadh	California State University, Fresno	LIDAR Intensity Images Balancing and Potentials
3:50 PM	11.155	Verdone, Gian Rocco (unable to attend)	e-GEOS	Improvement of COSMO-SkyMed Images Geo-Location Accuracy
4:15 PM	11.055	Kampes, Dr. Bert	Fugro EarthData, Inc	Results of the Fugro GeoSAR Airborne Radar for the Alaska Statewide DEM Project

4:40 p.m. Conference wrap-up, Greg Stensaas, USGS - Drawings, must be present to win!

5:00 p.m. Adjourn

PRESENTERS and MODERATORS
Biographies



Planning Committee

Michael Benson

Mike currently works on the Remote Sensing Technologies Project at USGS EROS supporting satellite and aerial remote sensing certifications and calibrations. Prior to 2008 he also was project manager for the USGS implementation of the US Commercial Remote Sensing Space Policy and currently is the Project Lead for Commercial Data Management at EROS. From 1993 - 2005 Mike worked in other capacities at EROS including management of the USGS data production and distribution. Prior to 1993 Mike was a Photographic System's contract manager at NASA's Johnson Space Center in Houston, Texas for four years and before his work at NASA he spent nine years at EROS as a contractor Image Scientist. Academically, Mike received his BS in Imaging Science in 1976 from Rochester Institute of Technology.

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Paul Bresnahan

Paul Bresnahan is employed by Observera Inc. and supports commercial satellite imagery geolocation accuracy evaluations as a contractor for the National Geospatial-Intelligence Agency (NGA). He has led geolocation accuracy assessments for IKONOS, QuickBird, OrbView-3, EROS-A, EROS-B, SPOT-5, Radarsat-2, Cosmo-Skymed, TerraSAR-X, RapidEye, WorldView-1, WorldView-2, and GeoEye-1. He received an M.S. degree in Geodetic Science (Photogrammetry track) from The Ohio State University and a B.S. degree in Aeronautical/Astronautical Engineering from the University of Illinois at Urbana-Champaign.

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Dr. Andreas Brunn

Andreas Brunn holds a masters of Geography and Remote Sensing from the University of Wuerzburg, Germany
and a PHD in Remote Sensing from the Technical University of Clausthal, Germany.

He currently works for RapidEye AG, in Germany in the Calibration and Validation Group as a calibration specialist.

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Gyanesh Chander

Gyanesh Chander received the M.S. degree in Electrical Engineering from South Dakota State University (SDSU), Brookings, in 2001. He is currently a Lead Systems Engineer with SGT, Inc., at the U. S. Geological Survey (USGS) Earth Resources Observation and Science (EROS) Center, Sioux Falls, SD. His primary responsibilities at EROS include satellite sensor characterization and calibration research to support on-going radiometric projects. He is leading the Group on Earth Observations (GEO) task DA-09-01a_8 to establish a catalog of prime candidate worldwide test sites for the post launch characterization and calibration of space-based imaging sensors.

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Agency Speaker

Dr. Changyong Cao

Changyong Cao is a research physical scientist at the NOAA/NESDIS/Center for Satellite Applications and Research (STAR) with 20+ years of experience in satellite remote sensing systems. He currently chairs the calibration working group for the next generation geostationary satellite GOES-R. He also leads the VIIRS sensor science team for the Joint Polar Satellite System (JPSS). He chaired the CEOS Working Group on Cal/Val for the international space agencies from 2007 to 2008. Prior to joining NOAA, he had 5-yrs of aerospace industry experience supporting NASA's hyperspectral missions. He earned a B.S.(1982), and Ph.D.(1992) degrees respectively from Peking University and Louisiana State University in geography/remote sensing. He was recipient of US Department of Commerce Gold(2) and Silver(1) medals and has nearly 30 journal publications.

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Planning Committee

Jon Christopherson

Jon Christopherson works at the USGS EROS Center as a contractor for SGT, Inc. With degrees in Electrical Engineering and Space Studies he has worked with ground, airborne, and space-borne electro-optical sensors for twenty-five years in various defense, aerospace, and civil programs, both domestically and internationally. He currently manages a contractor team supporting the USGS Remote Sensing Technologies Project's work in the assessment of satellite and aerial data as well as other tasks across the broad spectrum of remote sensing.

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Jeff Clauson

Jeff Clauson works at the USGS as a contractor for SGT, Inc. Degrees held include: Electrical Engineering, Mechanical Engineering, and Engineering Physics. He currently works within the USGS Remote Sensing Technologies group at the Earth Resources Observation and Science (EROS) Center as a Systems Engineer.

Jeffrey (Jeff) T. Clauson
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Philippe Déliot

Ph. Déliot obtained a physical engineer grade in 1987. He has been working at ONERA since 1989 in the applied and theoretical optics department. He was firstly in charge of infrared sensor conception and realization. Since 2000, he has been working on subjects in relation with image quality in remote sensing and particularly with calibration of airborne system and development of defocusing correction method for sensor after launch. He is currently involved in hyperspectral acquisition and image processing.

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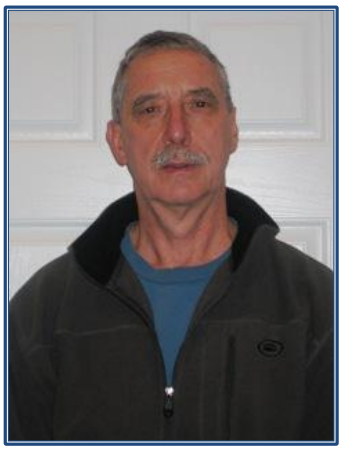

John Findley

John Findley has over 30 years of experience in the geographic and geospatial domain. This experience includes a Federal career at the U.S. Geological Survey in applied research using GIS and Image Processing systems. In his later years, John was deputy program manager for the Geographic Analysis and Monitoring Program which examined landscape change within the US.
John retired from Federal service in 2004, and joined Booz Allen Hamilton. He currently works on client site at the National Geospatial-Intelligence Agency. He has helped the NGA InnoVision Directorate to coordinate outreach activities, academic grants and to organize scientific workshops. Since June 2010, he has worked in NGA Acquisition Engineering Image Quality Branch supporting the Commercial Imagery Data and Programs office. John evaluates the radiometric accuracy of commercial imagery, assists in testing and evaluating GIS software, and helps his NGA client coordinate Joint Agency Commercial Imagery Evaluation activities.

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Leila M.G. Fonseca

Education:
Survey Electrical Engineering (1983);
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Doctor's Degree in Computer Science (1999).

Experience:
Senior Engineer at the Image Processing Division, Brazilian National Institute for Space Research (INPE);

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Dr. Michael Gruber

Michael Gruber was born in 1959 in Austria. He holds a degree in Surveying and Photogrammetry and a PhD degree from the Technical University Graz. From 1984-1990 he was employed at the Institute for Image Processing and Computer Graphics of Joanneum Research, where he was responsible for projects in Close Range Photogrammetry and Analytical Photogrammetry. From 1990-1992 he was on the staff of the Department of Remote Sensing, Image Processing and Cartography of the Technical University Graz. After a short period in a private mapping company he joined the Institute for Computer Graphics of the Technical University of Graz to lead the working group for 3D Object Reconstruction. He was responsible for several student lectures at the School of Information Engineering as well as for the supervision of student projects and diplomas of these projects.

From October 1999 to May 2006 Michael Gruber is full time staff of Vexcel Imaging Austria. He was responsible for all photogrammetric issues (Chief Scientist Photogrammetry) at Vexcel. In May 2006 Vexcel was acquired by Microsoft Corp., Redmond, WA. Since then Michael Gruber is full time employee at Microsoft. He is still responsible for all photogrammetric issues at the Graz office of Microsoft.

Michael Gruber holds several US patents for developments in digital photogrammetry, among them the basic concept of the digital aerial camera family UltraCam.

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Tom Heinrich

Tom Heinrichs is Associate Director for the Geographic Information Network of Alaska (GINA) at the University of Alaska. He leads GINA, performing general and technical management, program development, and outreach. Tom serves as the Executive Team representative for the University of Alaska for the Statewide Digital Mapping Initiative (SDMI), a multi-agency effort creating new ortho-imagery and DEM base layers for the entire state of Alaska. He is the program manager supervising the creation of a new Alaska statewide orthoimagery layer by the SDMI.

Tom and his team at GINA have created heavily used web services providing easy, high-performing access to imagery, elevation, and geospatial data for Alaska and the Arctic. He has also lead creation of high-impact partnerships with state, federal, and industry partners, resulting in the acquisition and distribution of Landsat 5, NOAA, NASA, and DoD satellite data to a broad audience.

Prior to joining GINA, Tom worked for the UAF Geophysical Institute's Computer Resource Center supporting the general infrastructure (DNS, mail, and web servers) and providing high-end Unix support to individual projects.

Prior to becoming a System Analyst, Tom was a Hydrologist and Project Manager, first with the USGS, then with Michael Baker Jr. Inc., a large private engineering consultancy.

He holds a B.S. in Physics from Stanford and a M.S. in Geophysics from the University of Alaska Fairbanks.

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Dennis Helder

Dennis Helder received the B.S. and M.S. degrees in electrical engineering from South Dakota State University and the Ph.D. in engineering from North Dakota State University. He has been involved with radiometric calibration of the Landsat series of instruments since 1988. He founded the SDSU Image Processing Laboratory in 1991 and is the current director. He has been involved with the Landsat 7 Science Team, the EO-1 Science Validation Team, and is currently a member of the Landsat Data Continuity Mission Science Team. Helder is currently the Associate Dean for Research in the College of Engineering at South Dakota State University.

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Dr. Bert Kampes

Dr. Kampes is involved in the optimization of the Fugro EarthData production workflow, in the development of novel radar products using the GeoSAR airborne radar system including the full-polarimetric upgrade performed under the NGA GSIP program, carbon accounting, segmentation, classification, and feature extraction, as well as in the development of the design specifications for a follow up airborne sensor.

Prior to working at Fugro EarthData, Dr. Kampes gained extensive knowledge of geospatial data acquisition, processing, and geospatial business processes through his work with various government and commercial organizations.

Dr. Kampes developed the public domain radar interferometric software package Doris at Delft University of Technology from 1998 onwards. He was Project Scientist at the German Aerospace Center (DLR), Oberpfaffenhofen, Germany, from 2001 to 2006, involved in several European Space Agency studies related to spaceborne radar such as SRTM, ERS, ENVISAT, and TerraSAR-X. More recently he was Manager of InSAR Services and Production at MacDonald, Dettwiler and Associates (MDA), Ottawa, Canada, from 2006 to 2008, where he was responsible for providing commercial radar services using RADARSAT-1 and RADARSAT-2 to governmental organizations such as NGA, and the Oil and Gas industry.

Dr. Kampes received the degree of MSc. in Geodetic Engineering from Delft University of Technology, The Netherlands in 1998, and his doctorate from the faculty of Aerospace Engineering, Delft University of Technology, The Netherlands in 2005.

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Dr. Taejung Kim

Dr. Taejung Kim is an Associate Professor in the Department of Geoinformatic Engineering at Inha University. He received his BSc degree at Korea Advanced Institute of Science and Technology in 1991 and his MSc and Phd degrees at University College London in 1992 and 1996 respectively. Before joining Inha University, he worked at Satellite Technology Research Center of the Korea Advanced Institute of Science and Technology (KAIST) as a senior researcher. His research interest includes automated quality assessment of satellite images, geometric modeling and calibration of satellite images, automated DEM generation and development of digital photogrammetric workstation.

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Gerald J. Kinn

Gerald J. Kinn is a senior member of ESRI's Imagery Team working with National Imagery Accounts. The team is focusing the enhancement of imagery capabilities in the ArcGIS platform. Mr. Kinn has more than thirty years of experience in systems engineering, design and implementation management for GIS and imaging solutions. Prior to joining ESRI, Mr. Kinn held engineering management positions with Trimble, Emerge, TASC and PAR Technology.

Mr. Kinn received his undergraduate and graduate degrees in Forest Engineering from SUNY College of Environmental Science and Forestry at Syracuse (SUNY/CESF). He is currently an adjunct faculty member of Virginia Tech, teaching graduate level remote sensing. He is has been a member of the ASPRS since 1976 where he has held local offices and has been recognized for leadership contributions.

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Edward Knight

Edward Knight has been working in Earth remote sensing for 18 years. He earned his Ph.D. in Optical Sciences from the University of Arizona and has been employed at Ball Aerospace & Technologies Corp. since 1999. He currently serves as the lead systems engineer for the Operational Land Imager, due to fly on the Landsat Data Continuity Mission in 2012.

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Dr. Frederico dos Santos Liporace

Frederico has a 10 years experience in the development of MS3, the ground segment software currently used by INPE, which includes all CBERS missions and Landsat MSS, TM and ETM. The software is responsible for the processing chain from real time data ingestion to L1T product generation.

Currently he is working as project manager and senior technical consultant on the MS3 extensions to support CBERS 3 and CBERS 4 cameras, and a new multi-satellite Catalog system. He is also working in the requirements gathering phase for the infrastructure necessary to deliver CBERS products to the African continent. He holds a Master degree in Electronic Engineering from Federal University of Rio de Janeiro, and a Doctor degree in Computer Science from the Pontifical Catholic University, also in Rio de Janeiro.

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Dr. Stephen Mackin

Steve Mackin is Chief Scientist for DMC International Imaging. He has worked in Remote Sensing for 26 years in industry, institutes and academia. His research interests include Hyperspectral Remote Sensing, GPS Reflectometry and the use of low cost sensors for novel application development. His current work, however, is aimed at the more practical approaches to the Calibration of Satellite Constellations, Automated Quality Control and Product Development for the DMCii satellite systems.

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Brian Markham

Brian Markham is a physical scientist within the Biospheric Sciences Branch at NASA's Goddard Space Flight Center. He works on the radiometric characterization and calibration of satellite, airborne and surface instrumentation. Currently he is the Calibration/Validation Manager for the Landsat Data Continuity Mission and the NASA calibration scientist for LDCM, Landsat-5 and Landsat-7.

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Preston Mattox

Preston Mattox is a Geodetic Engineer working in The Performance Engineering group at GeoEye. He received a B.S.E.E. from the University of Missouri in Columbia in 2008 and has worked for GeoEye since. Preston was a member of the GeoEye-1 checkout team and has continually performed image quality and calibration duties for the sensor. Current projects include image quality and calibration requirements definition and support for on-orbit calibration and check-out of the GeoEye-2 earth imaging satellite.

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Joel McCorkel

Joel McCorkel is the calibration scientist for the NEON Airborne Observation Platform responsible for instrument calibration, operational validation, and algorithm development. He earned his B.S in Optical Engineering and Ph.D. in Optical Science from the University of Arizona. Prior to joining NEON, Joel was a member of the Remote Sensing Group at the University of Arizona where he was involved with the on-orbit radiometric calibration of several Earth-observing satellite sensors.

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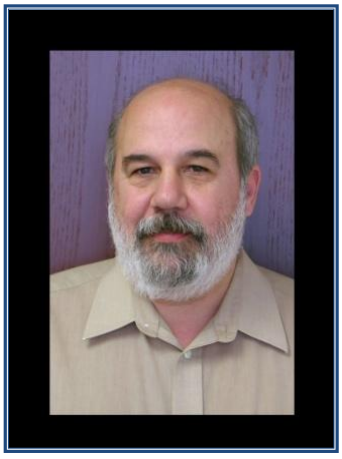

Dr. David Mulawa

David Mulawa is employed by GeoEye and supports the geolocation accuracy performance for the GeoEye-1 satellite. He has 20 years of experience in photogrammetric R&D and working with systems engineering. He has performed the on-orbit geometric camera calibration of the GeoEye-1 and OrbView-3 satellites. His current responsibilities include lead for the GeoEye-2 Geolocation IPT. He has received an M.S. degree in Geodesy and a Ph.D. degree in Photogrammetry from Purdue University.

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Dr. Riadh Munjy

Dr. Riadh Munjy got his MSCE in civil Engineering in 1978, MS in Applied Mathematics in 1981, and Ph.D. in Civil Engineering in 1982 from the University of Washington. He has been a faculty member and an active researcher at California State University, Fresno since 1982 and has been a Professor of Civil and Geomatics Engineering since 1988. He has over thirty years of experience in teaching courses in photogrammetry, digital mapping, GIS and least squares adjustment. From 1992 till 2003, he participated with JPL to develop an Interferometric Dual Band Radar Mapping System (GeoSAR). He has been a consultant in digital mapping for many agencies and firms around the world and worked as an expert witness in a number of cases.

A member of ASPRS since 1978, Munjy has been a regular participant in ASPRS annual and fall conventions. He served as the Chairman of the Close Range Photogrammetry from 1986 through 1988 and was associate editor for theoretical and applied photogrammetry for Photogrammetric Engineering and Remote Sensing journal from 1991 till 1996. In 1997 he was awarded the Meritorious Service Award by ASPRS.

He is a registered Civil Engineer in the State of California , a member of ASPRS and a certified photogrammetrist from ASPRS.

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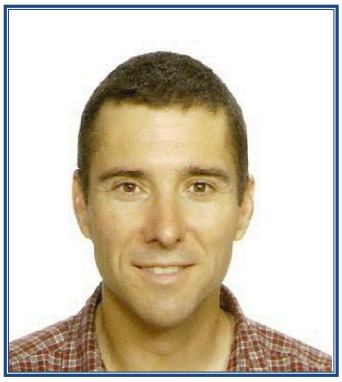

Denis Naughton

Denis Naughton obtained a B.S. degree in physics from the Catholic University of America in 1982 and a M.S.degree in optical engineering from the University of Rochester in 1986. Mr. Naughton has served in payload systems engineering, design, integration and calibration positions with the Ball Aerospace and Technologies Corp.,the US Army Electronic Sensor Directorate and the Eastman Kodak Company. He joined RapidEye AG in 2009 and currently manages the Calibration and Validation group which is responsible for maintaining the on-orbit imaging performance of the RapidEye sensors.

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Klaus Neumann

Klaus has a Master Degree in Electronic Engineering from the University of Applied Science in Aalen, Germany. He has been working more than 20 years for Carl Zeiss, Z/I Imaging and Intergraph. He had been involved in hardware and software design of high precision scanners and aerial mapping cameras. He is now worldwide responsible within Z/I Imaging for sensor system product management. He is a worldwide acknowledged expert for aerial camera systems.

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Mary Pagnutti

Ms. Mary Pagnutti holds a Master's of Science in Mechanical Engineering from the State University of New York at Stony Brook and has over 25 years of engineering experience ranging from large aerospace defense projects to civil remote sensing applications. From 1998-2007 Ms. Pagnutti supported NASA Stennis Earth Science programs where she helped to build a nationally recognized in-flight calibration/validation capability. In 2007 Ms. Pagnutti co-founded Innovative Imaging and Research, a company focused on developing technologies that integrate solid state lighting and imaging systems.

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Fabrizio Pirondini

Fabrizio Pirondini has a M.Sc.in Aerospace Engineer from the Polytechnic of Milan (Italy) and an Executive MBA from the Instituto de Empresa (IE), Madrid, Spain. After an experience in the European Space Operation Centre (ESOC) of the European Space Agency in Germany working on in-orbit infrastructure for manned missions, he went to Madrid, Spain were he co-founded in 2001, together with other 20 space professionals, DEIMOS Space S.L., which has grown to become, in 2010, a multinational group with four companies and more than 500 employees. In DEIMOS Space he has been responsible until 2010 of the Earth Observation Mission Analysis Division, having worked as Mission Analyst for more than 20 Earth Observation mission studies, mainly for ESA. In 2010 he joined DEIMOS Imaging as Business Development Manager.

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Dr. Ralf Reulke

Ralf Reulke studied physics from 1975 to 1980 at the Humboldt University of Berlin where he also received his PhD in 1984. From 1983 he worked in the areas of optical sensors, multispectral remote sensing and image processing. He was engaged in the development of sensors for space projects which served, e.g. for the investigation of the planets Mars and Saturn. Since August, 2004 he is a professor for computer vision in the computer science department of the Humboldt University of Berlin. At the same time he leads a group for image and signal processing in the German Aerospace Center (DLR).

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USDA Agency Speaker

Curt Reynolds

Curt Reynolds is the Deputy Director for the International Production Assessment Division (IPAD) of USDA's Foreign Agricultural Service (FAS) under the Office of Global Analysis (OGA) where he has worked for the past 12-years. Curt has been instrumental in developing several operational products and systems for global crop monitoring such as the flagship FAS Crop Explorer web site, and the cooperative USDA and NASA Global Agriculture Monitoring (GLAM) system and the Global Reservoir and Lake Monitor (GRLM).

Prior to joining USDA in 1998, Curt worked as a Project Manager in northern Kenya for a major water development project funded by the European Union from 1986-1991 and served in the US Peace Corps as a water engineer in northern Kenya from 1984-86. Curt also is an active member with the ASPRS (American Society for Photogrammetry and Remote Sensing), AGU (American Geophysical Union), ASAE (American Society of Agricultural Engineers), and ASCE (American Society of Civil Engineers) societies.

Curt received his Ph.D. (1998) and M.S. (1993) degrees from the University of Arizona in Agricultural and Biosystems Engineering and Civil Engineering/Water Resources Management, respectively; and a B.S. degree (1983) in Civil Engineering from the University of Wisconsin-Madison.

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Dr. Stephen Schiller is currently employed as a research scientist and systems engineer at Raytheon Space and Airborne Systems, El Segundo, CA developing in-flight calibration and validation methods for space-based and airborne imaging sensors. He was co-founder (with Dennis Helder) of the vicarious calibration program at South Dakota State University supporting numerous NASA and USGS remote sensing programs including the NASA/JACIE Commercial Satellite Calibration program in 2000/2001. Dr. Schiller received his Ph.D. in Astrophysics from the University of Calgary, Canada; M.S. degree in Astronomy from Ohio State University and a B.S. degree in physics from Walla Walla University.

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Agency Speaker

Dan Schuresko

Dr. Daniels Schuresko, the NGA Commercial Imagery Data and Programs CIDAP Technical Executive, is responsible for providing technical direction and guidance on the end use, development and acquisition of commercial systems for the National System for Geospatial-Intelligence.

Dr. Schuresko was formerly the Chief Scientist, IMINT Directorate, National Reconnaissance Office (NRO) where he supported the NRO's imagery programs and research efforts and provided strategic guidance to senior NRO management. In addition, Dr. Schuresko was NRO/IMINT's 'ideas catalyst", shaping advanced technical concepts and critical mission needs into new program activity.

Before entering government service in August 1988, Dr. Schuresko served as a Research Staff Member of the Oak Ridge National Laboratory. He supported the Department of Energy's Magnetic Fusion Program and participated in landmark experiments conducted at the Princeton Plasma Physics Laboratory and MIT Plasma Fusion Center to produce the first magnetic fusion plasmas that exceeded the equivalent conditions for fusion power breakeven.

Dr. Schuresko holds a Ph.D. in physics from Cornell University, with specialization in condensed matter science and engineering physics. He is regarded as a Community expert in remote sensing, with substantive expertise in the underlying engineering disciplines and significant experience in the major technical programs. Dr. Schuresko was awarded the National Intelligence Medal of Achievement in 2002.

Dr. Schuresko is the parent and mentor of three high achievement young adults.

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Guy Serbin has B.Sc. and M.Sc. degrees in Geology from Ben Gurion University of the Negev in Beer Sheva, Israel and a Ph.D. in Soil Science from Utah State University in Logan, UT. He has taught geosciences as a visiting lecturer at the University of Rhode Island in Kingston, RI, worked as a postdoctoral researcher at the USDA/ ARS Hydrology and Remote Sensing Laboratory in Beltsville, MD, and as a Crop Condition Analyst at ASRC Management Services and ASRC Research and Technology Solutions. He has authored several papers in the areas of remote sensing of soil moisture and crop residue cover. His current research is on remote sensing of crop residue cover, time-series analysis of remote sensing data, and agricultural in-situ and remote sensor requirements.

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Dr. Byron Smiley

Dr. Byron Smiley received his Ph.D. in physics from the University of Colorado at Boulder in 2002. In 2004 he started at DigitalGlobe, and at the time only assessed the geolocation accuracy of QuickBird-2 imagery. In 2007, when WorldView-1 was launched, Byron calibrated the panchromatic camera of WV01, and also began tracking it's accuracy with geolocation assessments like QB02. In 2009, when WorldView-2 was launched, Byron calibrated the camera models of all 9 spectral bands, and also folded it into his accuracy assessments. These days, he's analyzing WV02 stereo pairs, in addition to everything previously mentioned.

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Steve Stanzel

Steve Stanzel is the Microsoft General Manager of the Bing Maps Imagery Technologies teams located in Boulder, Colorado and Graz, Austria. Steve has worked in numerous products and functions during his 12 years with Microsoft and six years with Procter and Gamble. Originally from Sac City, Iowa, Steve graduated from Iowa State University with a Bachelor of Science in Mechanical Engineering and from the University of Iowa with a Master of Business Administration.

A seasoned Microsoft leader with a track record of building successful businesses, Steve previously contributed to Windows OEM business in production management and public relations roles, lead core product planning and strategy for MSN communications services such as Hotmail and MSN Messenger and lead the efforts to create the Windows Live services. Today his team is responsible for all the base maps and imagery for Bing Maps ranging from sensor design for the UltraCam aerial digital cameras to imagery acquisition strategy and partnerships, as well as imagery processing and updates to the Bing Maps service.

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Gregory Stensaas

Gregory L. Stensaas graduated from South Dakota State University with a Bachelor of Science degree in Mechanical Engineering, and has taken post graduate classes at the University of Nebraska–Lincoln and Dakota State University. Greg has electro-optical and infrared systems exploitation, development, simulation, and test experience as an electronics engineer and operations research analyst for the U.S. Department of Defense.

Greg experience also includes being principle engineer for the NASA Earth Observing System Distributed Active Archive Center and systems engineer for the U.S. Geological Survey (USGS) Landsat Data Continuity Mission at the National Center for Earth Resources Observation and Science (EROS).

Greg continues to work at USGS EROS in Sioux Falls, South Dakota and is currently serving as the USGS Remote Sensing Technologies Project Manager. where he is responsible for film and digital sensor calibration, satellite calibration, and system/product characterization.

Greg is a co-chair of the Joint Agency Commercial Imagery Evaluation (JACIE) program and the chair of the Inter-agency Digital Imagery Working Group. He is currently the Primary Data Acquisition Division (PDAD) Director for the American Society of Photogrammetry and Remote Sensing (ASPRS) and the vice chair of the Committee on Earth Observation (CEOS) Working Group on Calibration and Validation (WGCV).

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Nicolas Stussi

Nicolas Stussi is the Director of Services and Business Development for the GEO-Information Services division of Astrium in North America (formerly Spot Image Corporation). He has been with Astrium for over 11 years. Prior to his tenure at Astrium, Nicolas held several positions in the geospatial industry in both Europe and Asia.

He is currently responsible for the business strategy for the Pléiades and SPOT-6 & -7 satellites in North America. In addition, Nicolas is leading the development and implementation of new services and business models for Astrium GEO-Information Services.

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Dr. Jianwei Tao

Education:
1983-1987: Nankai University, Bachelor of Mathematics;
1987-1990: Beijing Aeronautics & Astronautics University, Master of Engineering;
2005-2009: Peking University, Doctor of Remote Sensing;
Title of doctoral thesis: moving object's information extraction from remote sensing image

Experience:
1990-2005: Working in the information center of Xinjiang Communication Department, carrying research work on highway snow hazard evaluation and prevention, soil remote sensing, road network extraction from remote sensing image;
2005-2009: working as a doctor in Peking University, doing research work on the orientation model of high resolution satellite sensors, moving object characteristics in remote sensing image, quantitative remote sensing of soil and inland water, such as salt content and type, chlorophyll-a content of water etc.

2009-now: Postdoc researcher in Geospatial Information Technology Center of Shanghai Jiao Tong University
Current projects:
Moving object's characteristics in WorldView-2 image, supported by DigitalGlobe;
Quantitative remote sensing the blue algae content of Taihu Lake by using WorldView-2 image, supported by DigitalGlobe;
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Mr. Thomassie has over twenty-six years experience in the remote sensing/GIS industry and joined DigitalGlobe in 1999. He assumes overall responsibility for managing DigitalGlobe's Civilian Government sales segment.

Prior to joining DigitalGlobe, Mr. Thomassie was a Program Manager for NASA/ITD – SpectralVisions and Project Manager for Lockheed Martin under the auspices of the NASA's Commercial Remote Sensing Program (CRSP) at Stennis Space Center in Mississippi.

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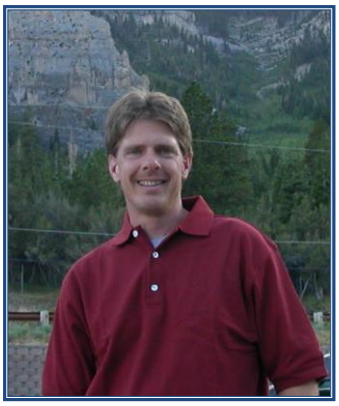

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Kurt Thome

Kurt Thome obtained a BS degree in Meteorology from Texas A&M University and MS and PhD degrees in Atmospheric Sciences from the University of Arizona. He then joined what is now the College of Optical Sciences becoming full professor in 2006. He served as the Director of the Remote Sensing Group from 1997 to 2008. Thome moved to NASA's Goddard Space Flight Center in 2008 as a Physical Scientist in the Biospheric Sciences Branch. He has been a member of the Landsat-7, ASTER, MODIS, and EO-1 Science Teams providing vicarious calibration results for those and other imaging sensors. He is a Fellow of SPIE and is serving as the calibration lead for the thermal instrument on the Landsat Data Continuity Mission and is the Deputy Project Scientist for CLARREO for which he is also the instrument lead for the Reflected Solar Instrument.

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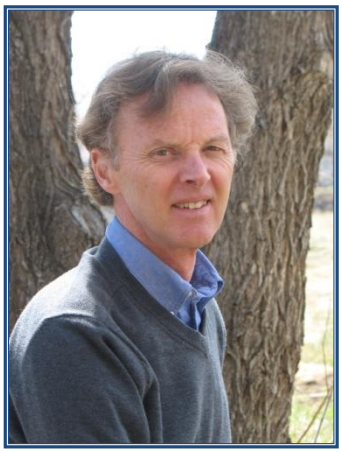

Agency Speaker

James Verdin

Jim Verdin is currently assigned by the U.S. Geological Survey (USGS) to the National Integrated Drought Information System (NIDIS) Program Office at NOAA in Boulder, Colorado, where he serves as Deputy Director. His research interests lie with the use of remote sensing and modeling to address questions of hydrology, agriculture, and hydroclimatic hazards. Jim has also led USGS activities in support of the USAID Famine Early Warning Systems Network since 1995. He has extensive experience in geographic characterization of drought hazards for food security assessment in Africa, Asia, and Latin America. Prior to joining USGS, he worked eleven years with the U.S. Bureau of Reclamation, including a three year assignment in Brazil. He holds B.S. (University of Wisconsin, Madison) and M.S. (Colorado State University) degrees in civil and environmental engineering, and a Ph.D. (University of California, Santa Barbara) in geography.

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Gian Rocco Verdone

Gian Rocco Verdone is employed by e-GEOS S.p.A. He is the Responsible of the product line of Earth Observation Services in e-GEOS, with the responsibility to define and manage the services of data downlink and products generation at the e-GEOS Matera Station. In COSMO-SkyMed scope he supports the added values product lines in the data exploitation and he is involved in the quality control of images and in the geo-location assessment of the mission.

He has a degree in Physics at the University "La Sapienza" in Rome and before working in the remote sensing he has been involved in the data analysis for geodesy for about 5 years in Telespazio company.

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Rueidi Wagner

Ruedi Wagner graduated in 1995 with a Masters degree in Applied Geology from the Free University of Berlin specializing in Remote Sensing, Photogrammetry and Geoinformation. Prior to joining Leica Geosystems in Switzerland in 2008, he has spent over a decade on the African Continent working as a scientist and manager in Applied Geospatial Imaging, as the Regional Manager Sub-Saharan Africa for Leica Imaging Products as well as a business consultant in corporate strategy and sustainable development.

Ruedi is based at Leica Geosystems' Headquarters in Heerbrugg, Switzerland, and is the Vice President Imaging of Hexagon Geosystems newly formed Geospatial Solutions Division.

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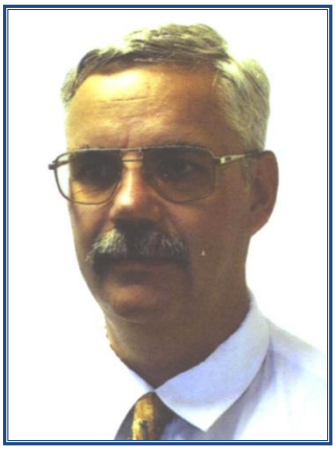

Horst Weichelt

Horst Weichelt has studied physics at the University of Potsdam, Germany. He has worked in the field of remote sensing for more than 30 years.
He currently works for RapidEye AG, Germany, in the Product Development Group as the deputy group head. He is also involved in the work of the Calibration and Validation Group.

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Joe Zamudio

Joe Zamudio received his Ph.D. in geology with an emphasis in remote sensing from the University of Colorado in 1992. His dissertation focused on geological applications of hyperspectral remote sensing. He worked with data from such sensors as the Airborne Imaging Spectrometer (AIS), and the Airborne Visible/Infrared Imaging Spectrometer (AVIRIS). During his career he has also worked with data from the Daedalus Multispectral Scanner, the Compact Airborne Spectrographic Imager (CASI), Landsat Thematic Mapper, the Thermal Infrared Multispectral Scanner (TIMS), and the HyMap/Probe hyperspectral sensors.

After receiving his degree, he joined the staff at the Department of Energy's Remote Sensing Laboratory in Las Vegas, NV. While there he was principal investigator for a project to evaluate hyperspectral remote sensing systems and their utility for environmental applications.

From 1995 to 2007 he has been involved in various hyperspectral remote sensing projects for a variety of clients, working at various times for Analytical Imaging & Geophysics, LLC, Applied Spectral Imaging, and Earth Search Sciences. During the course of that time, he analyzed hyperspectral data for mineral exploration, environmental monitoring, and vegetation studies. He also helped teach workshops on basic and hyperspectral data processing. Since 2007 he has worked for ITT Visual Information Solutions teaching workers from a variety of disciplines how to analyze remote sensing data using ENVI.

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ABSTRACTS
(numeric order)

11.005 Bresnahan, Paul

Geolocation Accuracy Evaluations of WorldView-1 and WorldView-2

The National Geospatial-Intelligence Agency (NGA) Civil and Commercial Applications Project (CCAP) is responsible for the assessment of civil and commercial remote sensing systems for the Department of Defense and Intelligence Community. A major component of the NGA CCAP evaluation process is the assessment of geolocation accuracy. CCAP assessed the absolute geolocation accuracy of WorldView-2 and re-assessed WorldView-1. CCAP presents the results of the assessment and compares the results to vendor-stated specifications and expected performance.

11.006 Bresnahan, Paul

Geolocation Accuracy Re-Evaluation of Cosmo-Skymed Spotlight and Stripmap Imaging Mode Products

The National Geospatial-Intelligence Agency (NGA) Civil and Commercial Applications Project (CCAP) is responsible for the assessment of civil and commercial remote sensing systems for the Department of Defense and Intelligence Community. A major component of the NGA CCAP evaluation process is the assessment of geolocation accuracy. As a follow up to the 2008-2009 assessment, CCAP assessed the absolute geolocation accuracy of additional Cosmo-Skymed Spotlight and Stripmap imaging mode products. CCAP presents the results of the assessment and compares the results to vendor-stated expected performance.

11.008 Bresnahan, Paul

Geolocation Accuracy Monitoring of High Resolution Commercial Imagery

One of the major functions of the Civil and Commercial Applications Project (CCAP) is to perform geolocation accuracy evaluations of commercial imagery being purchased or considered for purchase by the National Geospatial-Intelligence Agency (NGA). In the past, these evaluations typically have been performed during the initialization phase soon after satellite launch. Because of the longevity of commercial imagery satellites, CCAP has realized the need to continue performing geolocation accuracy evaluations beyond the initialization phase. Therefore, CCAP has established a monitoring program to track commercial imagery geolocation accuracy performance. The program began with WorldView-1 and GeoEye-1 and has since been expanded to include IKONOS and QuickBird. Additional satellites will be added as they become available. CCAP describes the monitoring program and presents the performance results thus far.

11.009 Bresnahan, Paul

Geolocation Accuracy Evaluation of Radarsat-2 Spotlight and UltraFine Imaging Mode Products

The National Geospatial-Intelligence Agency (NGA) Civil and Commercial Applications Project (CCAP) is responsible for the assessment of civil and commercial remote sensing systems for the Department of Defense and Intelligence Community. A major component of the NGA CCAP evaluation process is the assessment of geolocation accuracy. CCAP assessed the absolute geolocation accuracy of Radarsat-2 Spotlight and UltraFine (Stripmap) imaging mode products.

CCAP presents the results of the assessment and compares the results to vendor-stated expected performance.

11.010 Brunn, Dr. Andreas

Spatial Resolution Assessment of RapidEye Image Products

The RapidEye satellite constellation with its five multispectral imagers (MSI) has a potential imaging capacity of more than 4 Million km² per day. Each MSI has five distinct spectral bands and RapidEye image products are typically processed to a radiometrically corrected and band-to-band registered 1B product or to a tile based orthorectified 3A product. The band registration as well as the orthorectification processes require a resampling algorithm to fit the bands to each other or to fit the image into a map projection.

Currently there are three available resampling kernels: nearest neighbor, cubic convolution, and a modulation transfer function (MTF) enhancement kernel. This presentation discusses the effect of the different resampling kernels on image quality using Relative Edge Response (RER) and MTF estimations of RapidEye image products.

The spatial resolution characteristics of satellite imaging systems are typically assessed by analyzing images of specially deployed resolution targets. The image products' RER and MTF in this study are estimated using high-contrast edges found in typical urban scenes. These calculations are performed with a special tool developed for RapidEye by collaborators at Humboldt University-Berlin and are compared to results from external partners.

11.017 Goward, Chander, Pagnutti

Complimentarity of IRS-P6 AWiFS and Landsat TM/ETM+ sensors for Land Cover Change Analysis

The applied science community is showing increased interest in moderate spatial resolution (MODRES: 10-100 m) satellite remotely sensed observations as a primary source of land cover dynamics information. The precedence established by Landsat, starting in 1972, of acquiring and analyzing within-year and between observations of land cover as a means to evaluate land cover change, has recently been strongly advanced by the U.S. Geological Survey's (USGS) decision to provide cost-free access to the Landsat archive at the USGS Earth Resources Observation and Science (EROS) Center. Several world nations have joined the Landsat MODRES observatory club include France and India in the 1980's and more recently China and Brazil in the 1990s. In addition, the aging of the US Landsat observatories along with painfully slow progress to move toward deployment of the next-generation Landsat Data Continuity Mission (LDCM), raised concerns of whether Landsat-based applied sciences could continue in the absence of one or more Landsat observatories. Further, through Committee on Earth Observation Satellites (CEOS) and Group of Earth Observation (GEO) increased interest has been expressed in combining US with international sources of MODRES observations to implement a more temporally dense observatory, consisting on a constellation for International MODRES assets.

This study is exploring the complimentarity of the India's Resoucsesat Advanced Wide Field Sensor (AWiFS) with the Landsat Thematic Mapper based sensors flown on Landsat 4, 5 and 7.

This paper focuses on radiometric, geometric, spectrometry, cross-calibration, swath width, bidirectional reflectance distribution function (BRDF), and science assessments of these two sources of MODRES data to strengths and possible limitations in using observation sets to address the same applications foci. Overall we have found that the AWiFS sensor provides observations that are comparable to and complimentary to the Landsat TM based measurements. There are some differences between these imaging systems, such as spectral band response, pixel dimensions, swath width and radiometric resolution. However none of these differences are found to strongly limit comparable analyses. In fact, the higher radiometric resolution (10 bits), larger swath area coverage (740 km), and a frequent repeat cycle (five days) AWiFS is found to substantially enhance this source of images, while the coarser resolution (56 m) and lack of an AWiFS equivalent to the Landsat spectral Bands 1, 6 and 7 can have an adverse impact on a few assessments. On the other hand, we have found several aspects of the AWiFS sensor such a band-to-band registration and radiometric degradation over time which have not been well characterized to date. The experiences gained with Landsat, particularly with respect the Landsat Project Science Office (LPSO) and the Image Assessment System (IAS), should serve as a model of what analyses are needed to work with observations a constellation of international MODRES observatories.

11.025 Liporace, Dr. Frederico dos Santos

CBERS Program Update

This talk will present the current status of the CBERS program, from a technical, distribution policy and planned schedule perspective. From the technical perspective, the details of each one of the four CBERS 3 and 4 cameras will be shown. The presentation will cover geometric and radiometric aspects. The new CBERS satellites have an improved Attitude and Orbital Control Subsystem over CBERS 1/2/2B that will improve geometric precision, these differences will also be covered.

The CBERS program was the first one to implement a free data distribution policy for mid-resolution images. The presentation will cover how this policy will be maintained and extended for the next satellites. It will also include an update on the ground stations outside Brazil and China that will receive and distribute CBERS data. Finally we will present the planned dates for the major next CBERS 3 milestones, including launch and start of data production.

11.030 Déliot, Mr. Philippe

On-orbit defocus assessment of satellite cameras using neural network

For optical sensor onboard a satellite, it is essential, after the launch, to achieve the better quality image before starting the commercial commissioning. One of the expected issues of this stage is the correction of possible defocusing of the optical system. This defocusing can be due to several causes like moisture desorption of the optical structure, thermo-elastic effects, and vibrations during launch.

To become independent of the acquisition of a special calibration site, we developed a defocusing assessment using neural networks without reference targets. We take advantage of

the landscape in the image to provide test and learning samples to the neural networks: We compute from the images several features that change with the shift of focus. Thanks to a focusing mechanism, we indeed have the ability to acquire images with different steps of the focusing mechanism. The features are related to frequency domain and derived also from first moments or variograms. Taking into account symmetry properties of the defocus phenomenon, we retrieve the best position of the mechanism, which is the better plan of focus. This method can give information according to the row or column direction of the image and at different locations in the camera field of view. We applied this method on data provided by SPOT sensor.

11.035 Mattox, Preston

Introducing the GeoEye Sensor Performance Lab

The GeoEye Sensor Performance Lab (GSPL) provides image quality and geospatial accuracy assessment services for GeoEye and third-party satellite and aerial imagery providers. This paper describes the GSPL capabilities and provides examples of image quality assessment methods and tools. The lab's core competencies include measurement of image MTF, SNR, banding and streaking, focus mirror position, and performing radiometric calibrations and corrections. For example, image quality and geolocation calibrations can be performed on imagery from any operational system given an adequate math model of the camera's optical system and images of suitable radiometric targets. Geolocation metrics for monoscopic and stereoscopic imagery are computed using high-accuracy ground control points within our global set of test and evaluation sites. Value-added consulting services are described which serve the industry with sensor-agnostic quality assessments, periodic calibration services, image processing and enhancement, and domain expertise in geospatial intelligence and remote sensing product evaluations**.**

11.038 Fonseca, Dr. Leila M.G.

Enhancement of HRC and CCD images of the CBERS-2B Satellite

Two cameras of medium and high spatial resolution are onboard CBERS-2B (China-Brazil Earth Resources Satellite) satellite: HRC (Panchromatic band, 2.7 m) and CCD (20). Both images CCD and HRC present a blurred appearance. Besides, the images CCD have striping noise effect, which make the image analysis process difficult. In this study we propose to evaluate some restoration and enhancement techniques based on Fourier Transform, statistic measures and wavelet transform to improve the quality of CBERS-2B images.

11.040 Gruber, Dr. Michael

The Evolution of Vexcel's Camera Calibration and Image Processing Technology

Vexcel Imaging Austria offers digital airborne camera technology since 2003 and developed a special calibration and image processing technology in order to achieve highest image quality. The process is implemented in the so-called UltraMap Platform Software Suite and consists of three major steps:

• the introducton of the laboratory calibration data set
• the stitching process including POI selection and image matching
• the adjustment of the highly redundant set of image measurements

We present the latest results from the geometric and radiometric post processing methodology of the multi head digital aerial frame cameras UltraCam also known as Monolithic Stitching. Within the post processing of each frame after the flight mission the transformation parameters between layers of the multi cone design are computed via the stitching method. This stitching method includes observations from the panchromatic camera as well as physical parameters of the camera body and additional observations from the color cones of the multi head sensor system.

The geometric accuracy as well as the radiometric quality of the images are presented via data sets from production flights and illustrate the high quality of the method.

11.045 Heinrichs, Tom

Historic and Current Status of Alaska Orthoimagery and Elevation Mapping and Alaska Statewide Mapping Program Overview

Alaska currently has the oldest and least accurate maps of any state in the United States. There exists no statewide orthoimage base for Alaska. Un-rectified photography from the 1950's USGS statewide mapping campaign and un-rectified photography from the 1978-86 Alaska High-Altitude Photography project exist, but no statewide digital orthoimagery layer other than Landsat is available for Alaska. Most populated areas, including cities and remote villages, and some areas with economic resources, have been imaged at high resolution and have accurate orthoimagery available; these represent less than 15% of the state.

The current National Elevation Database (NED) for Alaska is coarse resolution: 2-arcsecond postings—roughly 30x60-meter cells at Alaska's high latitude. It was created by digitalizing the USGS topographic maps of 1950's vintage, many of which have significant accuracy limitations. The NED is known to contain large errors in some areas of the state. Less than 10% of the state currently has higher accuracy DEMs created with LIDAR, airborne IfSAR, or photogrammetrically.

The Alaska Statewide Digital Mapping Initiative, a multi-agency partnership, is addressing these shortcomings through two projects. One is the creation of a new statewide orthomosaic imagery baselayer at 1:24,000 NMAS accuracy (12.2-meters CE90). The entire state (1.56 million square kilometers) will be imaged with the SPOT 5 satellite, and a 2.5-meter spatial resolution, multi-spectral, pan-sharpened orthoimage will be produced by 2014. The second project is the collection of an improved accuracy DEM. The first phase is underway with 157,000 square-kilometers of airborne IfSAR data collected in 2010. A 5-meter post spacing, 20-foot contour interval accuracy equivalent (3-meter LE90) DEM and radar backscatter intensity image will be produced. Planning for orthoimagery refresh and completion of the statewide DEM are underway.

11.050 Helder, Dennis

Absolute Calibration of Landsat 1 through Landsat 5 MSS Sensors: Extending the Data Record Back Through Time (This paper to precede Dave Aaron's)

Previous to the Thematic Mapper (TM) instruments on Landsat 4 through 7, a high quality instrument series commonly called the Multispectral Scanners (MSS) was deployed on Landsat 1 through 3 and co-deployed with TM on Landsat 4 and 5. For long term studies (1972 to present), MSS data is the only available input. Originally the radiometric data from these sensors was specified to have an absolute radiometric accuracy of +/-10%. Based upon usage of pseudo-invariant calibration sites (PICS) and optimal site selection work previously done for the TM and ETM+ instruments, a methodical regressive recalibration of the MSS instrument was performed. This was done through the use of coincident or near coincident multiple image comparisons of sensor pairs based primarily upon desert PICS (in conjunction with spectral signatures of those scenes where necessary). The differences in calibration between MSS sensors has been reduced significantly. Most bands exhibited differences of greater than 10%. These have been reduced to 2% to 5% (depending on band). The MSS results were then placed on an absolute scale through use of the Landsat 5 TM, resulting in an absolute calibration to within 3% to 6%. Results from this work are being incorporated into the standard processing system at USGS EROS.

11.055 Kampes, Dr. Bert

Results of the Fugro GeoSAR Airborne Radar for the Alaska Statewide DEM Project

This paper presents Fugro EarthData's GeoSAR airborne Interferometric Radar (DbIFSAR) system technical details and processing results in relation to the Alaska Statewide DEM Collection Project. In this project, Fugro is a sub-contractor to Dewberry, tasked by the U.S. Geological Survey (USGS) to produce a Digital Elevation Model (DEM) of Alaska with 20-foot equivalent contour accuracy, as a major improvement over existing data of Alaska in the National Elevation Dataset (NED). The focus of this paper is on how data were acquired and processed to produce the Digital Terrain Model (DTM), the Digital Surface Model (DSM), and the Ortho-rectified Radar Imagery (ORI) in X-Band and P-Band.

The GeoSAR system is a full-pol, dual-band, dual-sided, single-pass interferometric radar system. As is well known, a single-pass radar can "see" through clouds and in the dark, and height estimation is not affected by atmospheric heterogeneities, as a repeat-pass system is. Being dual-sided, the GeoSAR system maps approximately 12-15 km wide swaths on both sides of the aircraft, from a nominal altitude of 39,000 feet, under a field of view of 25-60 degrees. Aside from the coverage advantage, the true advantage of a dual-sided system is the acquisition of multiple measurements in mountainous terrain. Specifically, the problem of layover and shadow is significantly mitigated by a dual-sided system, because a pixel on the ground is observed under different angles. Moreover, the inherent redundancy provided by the dual-sided system increases the reliability of detecting incorrect measurements and reducing the errors of the estimated elevations. The dual-bands are the X-Band and P-Band. The X-Band data are the basis for the DSM product, as the ~3 cm wavelength reflects of the first surface. The P-Band data (~86 cm wavelength) are the basis for the DTM product as it penetrates vegetation, making measurements of the elevations below the canopy. Finally, the GeoSAR system is augmented

with a modified Leica ALS40 profiling LiDAR, which is used to obtain ground control points for quality assessment. Main results and processing methods will be shown.

11.060 Kim, Taejung

Automated assessment of NIIRS and GRD of high resolution satellite images through edge profile analysis of natural targets

As high resolution satellite images become more and more popular, image quality has been one of the key concerns for scientific and industrial applications. At previous JACIE workshops, several authors discussed the automated estimation of spatial resolutions of high resolution satellite images. Notably, Pagnutti and Ryan at JACIE 2010[1] discussed the possibility of automated estimation of RER (Relative Edge Response) and MTF (Modulation Transfer Function) ratio at a cutoff frequency from edge profile analysis of natural targets. In this paper, we propose to use NIIRS (National Imagery Interpretability Rating Scale) and GRD (Ground Resolvable Distance) as measures to describe spatial resolution of high resolution satellite images. They can be estimated without Fourier Transformation of edge profiles and hence are free from accuracy problems related to interpolation and curve fitting. We also propose to use natural targets, instead of artificial ones, for edge profile analysis and NIIRS/GRD estimation. We introduced this concept firstly at IGARSS 2008[2] and discussed further at ASPRS 2010[3]. We have achieved automated estimation of NIIRS and GRD from natural targets by developing a reliable edge profile analysis technique and by designing systematic and efficient edge selection scheme. At the workshop, we will show that automated edge analysis from natural targets have shown comparable performance to manual edge analysis from natural and artificial targets. We will also compare the NIIRS and GRD estimated by the proposed technique with the true values.

[1] Pagnutti, M. and Ryan, R. E., 2010. Au automated tool to estimate the spatial resolution of products acquired by high spatial resolution remote sensing imaging systems. JACIE workshop, Fairfax, V.A., March 17.

[2] Kim, T., Kim, H. and Kim, H.S., 2008. Image-based estimation and validation of NIIRS for high-resolution satellite images. International Archives of Photogrammetry, Remote Sensing and Spatial Information Sciences, XXXVII(B1):1-4, Beijing

[3] Kim, T., Kim, J.-I., Kim, D. and Jeong, J., Automated image interpretability assessment by edge profile analysis of natural targets. Proceedings of ASPRS 2010 Annual Conference, San Diego, California, April 26-30. (in CD-ROM)

11.065 Kinn, Gerald J.

ArcGIS Geometric Accuracy Evaluation

ArcGIS allows professional and novice GIS users to do image georeferencing and orthorectification without the need for extensive photogrammetric background. The workflows support a wide variety of sensor outputs and therefore make imagery and the associated photogrammetric tools available to a large GIS user base. ESRI is conducting an extensive geometric accuracy evaluation exercise, performed independently by Navmatica's subject matter experts. It is critical to establish the accuracy of these tools and to publish best practices in order to advance new applications of imagery in GIS.

In this paper, the initial geometric accuracy evaluation is presented for one of the airborne mapping sensors, namely Trimble DSS which is a medium format 39 Mega Pixel camera including Applanix POSTrack for positioning, orientation and flight management, and an Azimuth Mount. Two data sets have been made accessible by Trimble Applanix for this study. One of the aforementioned data sets has been flown over a test fields in Mount Albert, Ontario and the other flown over another test field in Newmarket, Ontario. A number of well distributed and signalized Ground Control Points were also provided for this study. The data set included the entire raw data including the DSS imagery, the GNSS/Inertial data, the system calibration parameters, the ground control points coordinates and description. One of the flights includes a full LiDAR survey.

The key objectives of the independent geometric accuracy evaluation of ArcGIS are: a) To evaluate the level of accuracy that ArcGIS consistently provides. b) To analyze the repeatability, consistency and reliability of ArcGIS, and c) To evolve and document workflows that are "best practices" together with associated advantages and disadvantages. The Ortho images generated by ArcGIS are going through full geometric accuracy analysis where the Digital Elevation Model (DEM) in use is analyzed, the final orthos are evaluated using GCPs and densified GCPs. Four different DEM data sets will be used to generate the orthomosaics: namely: ASTER 30 m data, SRTM 90 m data, LiDAR-derived DEM, and DSS self-extracted DEM using the DSS aerial imagery. The effect of each of the four DEM sources on the quality of the final orthomosaics is currently being analyzed and compared to error propagation models. In this paper the geometric accuracy evaluation results will be presented in detail, where the effect of the DEM on the Orthorectification accuracy will be presented and the orthomosaics geometric accuracy will be presented for the two test flights in Mount Albert and Newmarket.

11.070 Knight, Edward

The Operational Land Imager: Overview and Requirements

The Operational Land Imager (OLI) will be the main instrument on Landsat-8 when it launches in 2012. OLI represents a generational change from heritage Landsat instruments in its design but must maintain data continuity with the 30+ year Landsat data archive. As a result, OLI has undergone a stringent calibration and characterization campaign to ensure its characteristics are understood and consistent with past instruments. This paper presents an overview of the OLI design, its major differences from previous Landsat instruments, and a summary of its expected performance.

11.075 Mackin, Stephen and Chander, Gyanesh

Cross-Calibration trending of the 2nd Generation DMC SLIM-6-22 and Landsat 7 ETM+ sensors over the Libya 4 CEOS reference pseudo-invariant test site

DMCii satellites do not have onboard calibrators and therefore have been exploring the possibility of tracking specific satellite systems as a means of providing a robust calibration strategy for its constellation of satellite systems. For the last year, the TOA reflectance from the DMCii and the Landsat 7 ETM+ sensors were compared, tracked, and trended over the CEOS reference "pseudo-invariant" Libya 4 test site.

Initial results suggest it is possible to track Landsat 7 ETM+ at the sub-1% level (one sigma) over a one year period at the site. Problems occur with variability in the TOA Reflectance due to varying solar elevation throughout the year, with additional issues related to the varying view angle of the DMC satellites due to their wide field of view and the asymmetry of the poorly defined BRDF of the dune filled Libya 4 site.

Even given these difficulties the results suggest that the method provides credible results to track different platforms and any biases between them, and help address global Earth observation data quality, reliability and inter-operability concerns within the GEOSS.

11.080 Markham, Brian

The Landsat Data Continuity Mission: Status and Plans

The Landsat Data Continuity Mission (LDCM) scheduled for launch in December 2012 is the follow on to the currently operational Landsat 5 and 7 satellites. Two instruments, the Operational Land Imager (OLI) and the Thermal InfraRed Sensor (TIRS), provide the reflective and thermal bands on LDCM, respectively. Key changes from previous Landsat missions are that the instruments are pushbroom, 12 bits, with two additional reflective bands at 443 nm and 1375 nm (cirrus) and with a split window (dual band) thermal capability. The OLI instrument is in integration and test with delivery scheduled for Spring 2011; The TIRS instrument is beginning integration and is scheduled for delivery in Winter 2012. On board calibration capabilities of the two instruments will be described in separate presentations. Like previous Landsat systems, a combined USGS and NASA calibration team will characterize and calibrate LDCM data once LDCM is operational using an Image Assessment System that is part of the ground system at USGS's EROS center. OLI data products will be orthorectified and distributed at no cost to the user.

11.085 McCorkel, Joel

Airborne remote sensing instrumentation for the National Ecological Observatory Network

The National Ecological Observatory Network (NEON) is an ecological observation platform for discovering, understanding and forecasting the impacts of climate change, land use change, and invasive species on continental-scale ecology. NEON will operate for 30 years gathering long-term measurements at sites distributed within 20 ecoclimatic domains across the contiguous United States, Alaska, Hawaii, and Puerto Rico. There will be an average of three sites per domain where flux tower and field measurements will be coordinated with high resolution, regional airborne remote sensing observations. The airborne instrumentation package consists of an imaging spectrometer covering the visible to shortwave infrared spectrum, waveform lidar and high-resolution camera. Three of these airborne packages allow routine coverage of NEON sites (60 sites nationally) and provide the capacity to respond to investigator requests for specific projects. To reduce risk during NEON construction, a spectrometer design verification unit is under development by the Jet Propulsion Laboratory to demonstrate that the design meets performance and operational requirements. Additional activities include airborne test flights with similar technologies to reduce science data product development risk. The capabilities,

operational plans and test flight results of the NEON Airborne Observation Platform are presented.

11.095 Mulawa, Dr. David

GeoEye-1 Geolocation Assessment and Reporting Update

The GeoEye-1 high-resolution imaging satellite continues to provide very good geolocation accuracy performance. This update includes the absolute and relative geolocation accuracy assessment test results from 2010 and Q1 2011. The Field Angle Map and camera interlock angle calibration methods that were used are described. Support for the GeoEye-1 Community Sensor Model (CSM) is outlined.

11.096 Munjy, Riadh

LIDAR Intensity Images Balancing and Potentials

Despite the remarkable achievements in LIDAR technology and data processing, LIDAR intensity does not match the images produced by digital cameras. Recent new research effort by the author shows very promising results in improving the LIDAR intensity images that can be used in various mapping applications as an ortho-rectified imagery. The new approach has been applied on different commercial LIDAR systems with excellent success including RGB LIDAR imagery.

11.100 Naughton, Denis

Radiometric Performance Assessment of the RapidEye Constellation

RapidEye AG is a commercial provider of satellite based image products. The source of this image data is the unique RapidEye constellation of five LEO satellites. The Multi Spectral Imager (MSI) on board each satellite provides data in five discrete spectral bands (blue, green, red, red-edge and near-infrared) of the electromagnetic spectrum. The general approach to the radiometric calibration of the sensors was based on establishing an initial pre-launch calibration in the laboratory (phase 1), confirming the calibration immediately after launch (phase 2), and then maintaining a consistent on-orbit calibration of the five sensors for the remainder of the mission (phase 3).

The on-orbit relative radiometric performance is maintained by monitoring both the pixel-to-pixel spatial uniformity and the temporal stability of each sensor. The spatial calibration process was designed to maintain the CCD response uniformity for each array on every spacecraft. It relies on statistical analysis of the large volume of image data collected during normal operations. The temporal calibration process was designed to maintain the band-to-band response for each sensor across the constellation. It relies on the analysis of image data collected over designated pseudo-invariant ground calibration sites which are acquired on a monthly basis. Verification of the on-orbit absolute radiometric accuracy was performed from April 2010 to May 2010 following updates to ground segment processing parameters that were derived from the outcomes of an in-depth vicarious calibration campaign conducted from April 2009 to October 2009.

This presentation describes the operational methods and processes that are employed to maintain the constellation radiometric response in both a relative and an absolute sense as well as providing the current status of the radiometric accuracy of the sensors.

11.105 Neumann, Klaus

The new DMC II high resolution aerial sensor family

The new Intergraph Z/I Imaging DMC II camera family has taken a unique design approach to address user requirements. Using only one single large format monolithic camera head, the DMC II provides highest accuracy in X,Y,Z and perfect radiometric image quality. A single CCD with up to 250 MPixel and single optics lens module makes CCD mosaiking obsolete and thus reduces manual labor effort for radiometric image adjustment during post processing.
The DMC II sensor family consists of three configurations, DMC II 140, DMC II 230 and DMC II 250. Small CCD pixel size and long focal length allows collecting data better than 3 inch GSD. An excellent Pan to Color ratio addresses remote sensing requirements. During this presentation first results from projects flown with DMC II 140 and DMC II 230 will be presented.

11.106 Pagnutti, Mary

An Automated Method to Estimate In-flight Image Quality Parameters from High Spatial Resolution Imagery

Spatial resolution is one of the most important image quality metrics associated with high spatial resolution imaging systems. It depends on both ground sample distance (GSD) and image sharpness at a fixed GSD, and is critical when determining the utility of an image product. In addition to feature identification, image sharpness affects pixel mixing and therefore affects classification accuracy. While GSD is well defined, image sharpness is described various ways. For satellite systems, image sharpness has historically been defined by evaluating the modulation transfer function (MTF) of an image product at the Nyquist frequency. Even though MTF at Nyquist provides information on aliasing in addition to image sharpness, relative edge response (RER) better estimates image sharpness since it is less susceptible to noise and it can directly indicate percent pixel mixing. Most current methods for assessing these image quality parameters rely on pre-deployed engineered targets and as such are performed only at selected times within preselected scenes. They often depend on teams of researchers and maintained targets and can be very expensive to perform on a regular basis. To address this deficiency and build upon previous algorithms, an automated and highly robust Image Quality Estimation Tool has been developed that can estimate the MTF and RER of an image product by finding, selecting and utilizing uniform, high-contrast edges from typical acquired urban scenes. This presentation discusses the basis of the method, its validation when compared against traditional methods utilizing pre-deployed engineering targets, an uncertainty analysis and example results.

11.107 Pirondini, Fabrizio

The Deimos-1 Mission: Absolute Calibration and Data Validation

In October 2006, DEIMOS Imaging S.L. (Spain) and Surrey Satellite Technology Ltd. (UK) signed a contract to develop an Earth Observation satellite: the Deimos-1. The satellite was

launched in July 2009 and started acquiring images only 7 days after the launch. From that moment, Deimos-1 became the Spanish member of the operational Disaster Monitoring Constellation (DMC), joining its other international partners. DEIMOS Imaging owns, operates and markets the images and products of the Deimos-1 satellite anywhere in the world, having already signed distribution agreements with SPOT Infoterra, DMCii and other major partners.

The Deimos-1 incorporates many improvements with respect to the first-generation DMC satellites, being based on a much-improved version of the proven SSTL-100 platform. While maintaining the same mass, size and power consumption of the first generation, the Deimos-1 design includes various upgrades, like a better GSD at nadir (22m from 32m), improved quantization (10 bits from 8 bits) and lens quality, increased X-Band downlink rate (40Mbit/s from 8Mbit/s), and enhanced battery performances through a new Li-ion model which replaces the previous NiCd battery.

The heart of the Deimos-1 payload is the SLIM6 (Surrey Linear Imager Multispectral 6 channels) sensor, which is designed to provide high-resolution images of the Earth's surface in three spectral bands: NIR, Red and Green, along the 600 km of its swath. During the in-orbit commissioning, which lasted from July 2009 to February 2010, the main objective was to ensure that data were on a standard scale and making them compatible and comparable with the data acquired from other sensors.

In order to obtain the absolute radiometric calibration parameters, we used the CEOS procedure with data from 2009 Tuz Golu (Turkey) and Railroad Valley (Nevada). The calibration parameters were calculated using images from Deimos-1, Beijing 1, UK-DMC, and UK-DMC2 taken at the end of August 2009.

Before starting the absolute calibration process, we performed the equalization of all SLIM6 sensor detectors, characterizing their response on bright target images acquired over Dome-C (Antarctica) and dark target nighttime images over the Pacific Ocean. For the bright target, in order to offset the known anisotropy of snow's BRDF, the satellite has been maneuvered in yaw so that the sensor array was parallel to the solar principal plane, and all elements of the array experienced the same sun angle. The nighttime images over Pacific Ocean allowed determining the levels of response in the absence of signal and estimating the value of bias in the data due to the intrinsic noise of the sensor.

To achieve the radiometric calibration in both locations, some field measurements were taken, including atmospheric data, which allowed us to estimate the TOA radiance at the time of image acquisition. This information was associated with the digital readout of the sensor and allowed to convert it into the proper physical quantity of the radiance. The nighttime values over Pacific, along with values obtained in Tuz Golu, allowed us to produce the final calibration curve.

Currently, DEIMOS Imaging is monitoring the degradation trend of the sensor, using an acquisition program on the CEOS pseudo-invariant target "Libya-4", and comparing the results with images taken by Landsat and other DMC platforms. This procedure allows us to monitor any trends that may indicate a change in the status of sensors.

In August 2010 DEIMOS Imaging, through the DMC consortium, participated with Deimos-1 data in the 2010 CEOS Land Cal Event at Tuz Golu salt lake, along with seven other major space institutions (CMA, CNES, ESA, JAXA, KARI, NASA and USGS) and 11 other participants who comprised the ground crew.

The high quality of the data of the Deimos-1 satellite, achieved through a comprehensive absolute calibration process, has allowed to obtain a high level of customer satisfaction in the frame of various major international programs, including the Global Monitoring for Environment and Security (GMES) program and the ESA-DUE program, and with many international organizations like the United Nations, the European Maritime Safety Agency (EMSA), and the European Union Satellite Centre (EUSC). DEIMOS Imaging is currently developing the Deimos-2 satellite, a multispectral high-resolution (1m) EO satellite, whose launch is foreseen for 2013.

11.110 Ruelke, Dr. Ralf

Spatial Resolution Assessment of Real Image Data

The radiometric and spatial characteristics of a remote sensing system specify the image quality. The determination of the image quality is carried out on specific resolution targets. The point spread function (PSF) is an essential parameter for characterizing the spatial imaging properties of the whole system. We present an approach for PSF determination using high-contrast edges found in the typical urban scenes.

It is assumed that the PSF is described by a Gaussian. Instead of the PSF the edge spread function (ESF) was determined. For the investigations RapidEye multispectral orthophoto data (L3a) has been used. Clear transitions between bright and dark patches have been selected in the imagery. The analysis is carried out in a horizontal and vertical direction only. Because of the spectral dependence of the reflection properties, these transitions were examined for all of the five bands of the same image data.

This presentation describes a special tool to determine the data quality based on PSF estimations of RapidEye image products. It is also shown that the determination of the influence of different image processing algorithms is possible.

11.115 Schiller, Stephen

Measuring Atmospheric Optical Depth Directly from Satellite Imagery

Measuring Line of sight atmospheric optical depth is generally confined to the realm of observations recorded with a solar radiometer or derived indirectly by the application of radiative transfer models to absolute calibrated remote sensing radiance retrievals. However, an

innovative vicarious calibration approach known as the SPecular Array Radiometric Calibration (SPARC) method provides a new option. The SPARC method introduced the use of convex mirrors to produce an at-sensor irradiance of known magnitude scaled to the top-of-atmosphere solar spectral constant by the sun-to-mirror-to-sensor path transmittance. In this presentation is described an inversion procedure to this SPARC method that allows the retrieval of the atmospheric transmittance and consequently optical depth at any location in the world in which a convex mirror of known reflectance and radius of curvature producing a virtual image of the sun is imaged by a calibrated sensor. The sensor calibration for transmittance retrieval from the image data alone need only to be based on a relative response as is the case with a sun photometer. Validation will be demonstrated with image data recorded by GeoEye's IKONOS sensor.

11.120 Serbin, Guy

Advanced Multispectral Sensor Requirements for Remote Sensing of Agriculture and Land Cover

Modern agricultural and land cover monitoring programs require frequent data acquisitions and increased spectral resolution to acquire a greater number of parameters in a more accurate manner. Whereas hyperspectral sensors could provide the required information, agriculture's biggest need is for frequent revisit intervals over large areas, which cannot be met by pointing the sensor. Future meteorological satellites will provide frequent coverage over large areas; however, these sensors will not have the spectral bands required and the pixel sizes are too large for agricultural monitoring. Vegetation generally has the same spectral features, so an advanced multispectral system containing at least 13 spectral bands would be ideal for such purposes. Important biophysical parameters that would be monitored include live vegetation cover, chlorophyll content, vegetation water content, non-photosynthetic vegetation cover (NPV, e.g., crop residues and dry grasses), evapotranspiration, and vegetation stress. Remote sensing of NPV requires three shortwave infrared bands between 2.025 – 2.230 □m that allow for calculation of the Cellulose Absorption Index. While current and planned multispectral sensors can acquire most of these parameters, none are suited for remote sensing of NPV, which provides unique and important information about tillage practices, rangeland health, brush fire hazards, soil organic carbon dynamics, soil erosion, and water quality. We also include bands for atmospheric correction. Other requirements for an agricultural monitoring system are 12-bit or better quantization, signal-to-noise ratio > 250, temporal resolution < 7 days to ensure cloud-free scenes and to capture critical crop growth stages, and pixel size < 60 m. This concept is based on discussions about satellite data requirements for agricultural monitoring and does not represent official USDA or ARS policy.

11.125 & 11.126 (combined) Smiley, Dr. Byron

Geolocation Accuracy Topics Relevant to DigitalGlobe's Satellite Constellation

Each of DigitalGlobe's high resolution satellites, QuickBird-2 (QB02), WorldView-1 (WV01), and WorldView-2 (WV02), have a characteristic and unique geolocation accuracy. Using imagery over ground control points, the absolute geolocation accuracies of all three satellites have been monitored each month. Up to 2 years of quarterly geolocation statistics will be presented for all three satellites. Furthermore, WV02 stereos have been analyzed. A slightly

different geolocation accuracy can be obtained by computing the stereo intersection of gcps common to both images in the pair. The horizontal and vertical accuracy of WV02 stereos will be presented, in a quarterly format like the monoscopic statistics.

Immediately after launch, the camera models for all 9 spectral bands of WV02 were completely uncalibrated. Both panchromatic and multispectral imagery showed obvious relative geolocation errors like warping and rubbersheeting. After the on-orbit calibration to correct these issues, all 9 spectral bands were monitored over the following year to see if any further calibration was required. The relative accuracy of the panchromatic band was monitored with "criss crosses" of nature scenes, or north/south strips followed by east/west strips. The band-to-band registration of each multispectral camera was monitored using the other 8 multispectral bands of the same criss cross strips. Both criss cross and band-to-band statistics will be presented, showing that the relative geolocation accuracy of all 9 bands had not degraded since the initial calibration, no matter how much time had passed.

11.130 Stanzel, Steve

Microsoft Bing Maps Imagery Technologies: Commercial Imagery & Technologies

Microsoft Corporation first ventured into the world of geospatial imagery and technology in 1998 with the launch of Terraserver, its free online repository of public domain aerial imagery and topographic maps provided by the U.S. Geological Survey (USGS). Since that time, the company's evolution of geospatial commercial offerings has culminated with the release of its Bing Maps Enterprise web mapping application platform and consumer mapping web site based on that platform, formerly known as Virtual Earth and Live Search Maps, respectively. Bing Maps integrates best of breed geospatial imagery that includes satellite, high-resolution aerial and streetside views. These data, along with an extensive point of interest database, a highly accurate geocoder, gazetteer services, and a set of application program interfaces (APIs) for developers, are already being leveraged by many public sector agencies worldwide for their web mapping application needs.

Integral to the Bing Maps initiative is the Boulder Imagery Technologies (BITS) operation, centered in Boulder, Colorado and with offices in Graz, Austria. Under the direction of General Manager, Steve Stanzel, the BITS team is responsible for the acquisition of commercially available satellite and aerial imagery, as well as the development of technologies to capture and process high-resolution aerial views and mobile (Streetside) imagery. These efforts underpin the technological advancements of the UltraCam leading selling digital aerial cameras and have resulted in the UltraCamM mobile camera is being used exclusively for Streetside capture. Furthermore, the team manages the processing and the pipeline that prepares this wealth of data for Bing Maps and publishes it to the consumer web mapping service.

A core initiative for the BITS team is its Global Ortho program. Launched in the spring of 2010, Microsoft's Global Ortho program is an unprecedented and ambitious effort that will capture and process worldwide 30cm aerial imagery (inasmuch as that is possible) to provide Bing Maps with global orthorectified aerial views, beginning in the US and Europe. Leveraging its expertise

in photogrammetric hardware and software engineering, the BITS team developed specifically for the program a new UltraCam system, the UltraCam Giant—or UltraCamG (UCG)—a super large format digital aerial camera to enable the efficient capture of large swaths of aerial imagery at higher resolutions. Additionally, those efforts delivered innovative processing technologies to enable rapid othorectification, orthomosaiking and industry leading color balancing for superior image quality. Microsoft has made great efforts to outsource most of the required collection services for the GO program to a large number of renown players in the geospatial industry and has entered into an agreement with DigitalGlobe, a leading global provider of commercial high-resolution world-imagery products and services, that establishes DigitalGlobe as the exclusive offline distributor of Microsoft's GlobalOrtho product.

11.135 Stussi, Nicolas

Pleiades Program – Capabilities and Access

Astrium GEO-Information Services, leading provider of satellite imagery and geo-information services, is expanding its satellite portfolio with the addition of the Pléiades satellite constellation in 2011-12, and the SPOT-6 & -7 follow-on satellite program in 2012 & 13. The first of two Pleiades satellites, scheduled for launch in 2011, will offer access to 50cm optical satellite imagery expanding Astrium's portfolio to include very high resolution optical satellite imagery. We will provide an in-depth review of the Pleiades Program, capabilities, and present the product and services to be offered commercially starting in 2011.

11.137 Tao, Dr. Jianwei

A Preliminary study on imaging time difference among bands of Worldview-2 and its potential applications

WorldView-2 has 8 multispectral bands and 1 pan band. In its L1B level data files, these bands have the same camera model and orientation model. But based on the study of moving objects' characteristics in images from different bands, we found that, like the situation for QuickBird 2 sensor, different band has different imaging time. This poster introduced the calculation method for the imaging time difference of different bands of WorldView-2, reasoned out a possible CCD detector' layout of the focal plane, and pointed out some drawbacks of the current L1B level data of WorldView-2.

Secondly, this poster introduced some potential usage for the imaging time difference of different bands of WorldView-2, including ground traffic animation, ground traffic data collection.

11.143 Thomassie, Brett

DigitalGlobe Incorporated Satellite and Aerial Program Update

DigitalGlobe continues to operate a growing constellation of high resolution earth imaging satellites (QuickBird and Worldview systems) and added a growing aerial imagery program capability beginning in 2007 to complement its satellite product offerings. The overall DigitalGlobe data acquisition system's capacity to collect over 700 million square kilometers of

imagery data annually is well suited for temporal collection of large study areas globally and contributes to the rapid population and updating of its growing image library.

The QuickBird satellite features 60cm panchromatic resolution and 2.4-meter multispectral resolution and has been operating successfully since 2001.

The WorldView-1 launched in September of 2007. This high-capacity, panchromatic imaging system features half-meter resolution imagery. Operating at an altitude of 496 kilometers, WorldView-1 has an average revisit time of 1.7 days and is capable of collecting up to 750,000 square kilometers (466,000 square miles) per day of half-meter imagery. The satellite is also equipped with state-of-the-art geo-location accuracy capabilities and exhibits stunning agility with rapid targeting and efficient in-track stereo collection.

WorldView-2, was successfully launched October 8, 2009. Operating at an altitude of 770 kilometers, WorldView-2 will enable DigitalGlobe to provide half-meter panchromatic resolution and 1.8-meter multispectral resolution (8-bands). WorldView-2 will have an average revisit time of 1 day and is capable of collecting up to 700,000 square kilometers (434,000 square miles) per day of half-meter imagery. The WorldView-2 system allows DigitalGlobe to substantially expand its imagery product offerings to customers with a more desirable, higher-performance product. The added spectral diversity provides the ability to perform precise change detection, vegetation analysis and mapping. WorldView-2 incorporates the industry standard four multispectral bands (red, blue, green and near-infrared) and will also include four new spectral bands (coastal, yellow, red edge, and near-infrared 2).

The upgraded WorldView ground system (in use presently with QuickBird and WorldView-1) also includes a more efficient image processing system, multi-satellite collection planning, shorter tasking timelines, and an expanded network of remote ground receiving terminals.

In October 2009, DigitalGlobe partnered with Microsoft Corporation and launched the Advanced Ortho Aerial Program (AOAP – formerly called Clear30), an initiative to distribute high-resolution, 30-cm aerial orthoimagery (Advanced Ortho Series – Vision Premium/Precision Aerial product) of contiguous landscapes, initially in the U.S. and Western Europe. The AOAP initiative is a new program that reflects a DigitalGlobe commitment to increase accessibility and use of high-resolution digital imagery. To collect the first ever multicontinental aerial imagery at 30 cm spatial resolution (12-inch), DigitalGlobe and their partner Microsoft will use the UltraCamG, a large format digital aerial camera manufactured by Vexcel Imaging GmbH, a wholly owned subsidiary of Microsoft, which is based on Vexcel's UltraCam large format camera systems, the top selling large format aerial sensors internationally.

DigitalGlobe imagery products are designed to support a wide range of civil government project and research applications ranging from land management and natural resource management to asset monitoring and disaster/emergency response and remediation.

11.145 Thome, Kurt

Calibration overview for the Thermal Infrared Sensor (TIRS) on the Landsat Data Continuity Mission

The Landsat Data Continuity Mission consists of a two-sensor platform with the Operational Land Imager and Thermal Infrared Sensor (TIRS). Much of the success of the Landsat program is the emphasis placed on knowledge of the calibration of the sensors relying on a combination of laboratory, onboard, and vicarious calibration methods. Rigorous attention to NIST-traceability of the radiometric calibration, knowledge of out-of-band spectral response, and characterizing and minimizing stray light should provide sensors that meet the quality of Landsat heritage. Described here are the methods and facilities planned for the calibration of TIRS which is a pushbroom sensor with two spectral bands (10.8 and 12 micrometer) and the spatial resolution 100 m with 185-km swath width. Testing takes place in a vacuum test chamber at NASA GSFC using a recently-developed calibration system based on a 16-aperture black body source to simulate spatial and radiometric sources. A two-axis steering mirror moves the source across the TIRS field while filling the aperture. A flood source fills the full field without requiring movement of beam providing a means to evaluate detector-to-detector response effects. Spectral response of the sensor will be determined using a monochromator source coupled to the calibration system. Knowledge of the source output will be through NIST-traceable thermometers integrated to the blackbody. The description of the calibration system, calibration methodology, and the error budget for the calibration system shows that the required 2% radiometric accuracy for scene temperatures between 260 and 330 K is well within the capabilities of the system.

11.146 Thome, Kurt

Methods for radiometric cross-calibration of imaging sensors with and without overlapping collections

An important aspect of the use of imaging sensors is the characterization and calibration of those sensors and validation of their data products. There exist numerous methods for accomplishing the on-orbit characterization ranging from methods that include the reflectance-based approach which requires measurements of surface and atmospheric properties at the time of a sensor overpass to the use of invariant scenes which rely on knowledge of the temporal characteristics of the site being viewed. Cross-calibration methods are included in these on-orbit characterizations and this presentation examines typical cross-calibration methods and expected uncertainties of the methods. Proposed methods to mitigate the largest error sources in future systems are presented. A set of case study examples are also provided using historical Landsat, Ikonos, QuickBird, and Orbview data that act as the basis for a set of recommendations to ensure future SI-traceable cross calibration using future missions such as CLARREO and TRUTHS.

11.155 Verdone, Gian Rocco

Improvement of COSMO-SkyMed Images Geo-Location Accuracy

The localization of points in a SAR image requires different models compared to optical images as well as different algorithms to highlight the points in the images, because the pixel spacing in SAR images is smaller than image resolution. Moreover, the “oblique” (slant) nature of the

"observation" does not allow to use the same parameters to localize pixels at different look angles.
These effects make the geo-location of SAR images a little more complicated than the one implemented in almost all the existing commercial image processing softwares.
We have carried out a measurement campaign to better feature the parameters of COSMO-SkyMed images as well as to measure the effects due to the troposphere path delay and correct them.We want to make the fully potential geo-localization of the images easier to be used.

11.160 Weichelt, Horst

New RapidEye Image Products

The RapidEye satellite constellation has a potential imaging capacity of more than 4 Million km² per day. Standard image products have been generated within the past two years of operations from more than 1.4 Billion km² of the Earth's land surface.

Currently there are new RapidEye image products under development, adding more flexibility to the product portfolio offered by RapidEye. An improved cloud mask and new capabilities for the generation of image mosaics are cornerstones for the new products. RapidEye also offers new improved tools for searching products in the RapidEye image archive.

The presentation outlines the basic ideas and features of the new RapidEye image products, and in addition gives a short overview on ideas and requirements for the next (second) generation of the RapidEye satellite constellation.

11.161 Wagner, Reudi

New developments in airborne imaging – Leica RCD30 medium format camera and Leica XPro DSM surface model extraction

Leica Geosystems, a leader in airborne sensor solutions, has introduced two groundbreaking additions to its airborne imaging portfolio.

Leica XPro 5.0 DSM, a new module in Leica Geosystems proven line sensor workflow Leica XPro, allows surface model extraction and point cloud generation from airborne pushbroom imagery. Leica XPro DSM produces surface models with high point densities and high accuracies and opens the door to a new world of applications.

The new Leica RCD30 medium format camera is the world's first 60MP camera that can acquire co-registered multispectral imagery in RGB and Near-Infrared. In recent years some medium format cameras have established themselves as tools for photogrammetric mapping. The Leica RCD30 is ideal for remote sensing type application as well. In addition, the new Leica RCD30, purpose-built for airborne photogrammetric and survey missions, offers an impressive range of features such as motion compensation and a stabilized lens system. Available as a camera to be integrated with a LiDAR system, or as a standalone single or multi-head photogrammetric camera system, the Leica RCD30 is the ideal choice for those who seek modularity, flexibility and accuracy at an affordable price.

This presentation highlights the technology behind these new developments.

11.165 Zamudio, Joe (Presentation)

Spatial and spectral processing of ASTER and WorldView-2 data

The field of remote sensing has benefited greatly in the last several years most notably due to the increase in spatial resolution of data from commercial satellites. In addition, sensors that have more channels than previous multispectral sensors have been developed. ASTER and WorldView-2 are examples of satellites with increased spectral capabilities. More channels sampling more wavelengths equals more information, so typically more materials can be mapped with data from these sensors. Software developers have also been working to develop tools that analyze data in new ways. ENVI's Feature Extraction is one example of an object-oriented classification algorithm that classifies objects based in part by their spatial characteristics. The work presented here has focused on combining spatial and spectral data analysis techniques. Data sets from ASTER and WorldView-2 were analyzed in a two-step process. First, Feature Extraction was used to segment the data and classify the imagery based on shape. Then, selected features of interest were chosen for processing using tools that focus on spectral properties. These complementary techniques show promise in producing more precise and accurate information products derived from remote sensing imagery.

JACIE notes

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Thank You for attending the 2011 JACIE Workshop!

Program compiled by Carrie Jucht, SGT, contractor to the USGS/EROS